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ADDITIVE FOR FARM-RAISED FISH FEED AND FARM-RAISED FISH FEED

[Yogyo Shiryo Tenkazai Oyobi Yogyo Shiryo]

Noboru SUGIMOTO

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Claims

Claim 1.

An additive for farm-raised fish feed, comprising carotenoid incorporated at the rate of 0.1 g to 10 g in 100 g phospholipid.

Claim 2.

The additive of claim 1, wherein the phospholipid is phospholipid derived from soybean, rapeseed, chicken egg, or fish egg.

Claim 3.

The additive of claim 1, wherein the carotenoid is selected from astaxanthin, canthaxanthin, zeaxanthin, tunaxanthin, lutein, and β-carotene.

Claim 4.

A farm-raised fish feed that contains at least 2 g phospholipid and at least 3 mg carotenoid in 100 g feed.

Detailed Description of the Invention

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[0001]

Field of Industrial Utilization

The present invention relates to an additive for the feed for farm-raised fish. The present invention can improve the meat quality of farm-raised fish by providing an additive-containing feed.

[0002]

Prior Art

It has been frequently pointed out that the quality of the edible muscle of farm-raised fish is inferior to that of muscle from wild-caught fish. This difference in meat quality frequently presents itself as an impairment in the farm-raised fish of the bright red color of the dark muscle of, e.g., the Japanese amberjack, red seabream, Japanese flounder, and so forth, and in turn is frequently accompanied with regard to taste and smell by off-flavors and off-aromas. In addition, while the white muscle should be a transparent white, the deposition of melanin pigment in the capillary vessels results in the production of a

black filamentous pattern and thus in a dark color for the muscle, which impairs the commercial value.

[0003] Phospholipids are an important biological structural component and are present at about 0.1% or less in farm-raised fish feed, for example, the usual moist pellet or blended feed. In addition, phospholipids are added to feed as a calorie source and/or for the purpose of dispersing or emulsifying oils (JP A 03-007546, JP A 48-000077) and are also used as essential nutrients in the fry stage (JP B 61-043977, JP B 63-035223).

[0004] On the other hand, farm-raised fish feed contains about 0.3 mg carotenoid pigment; however, in order to provide the body surface of the koi or red seabream or the muscle color of the salmon or cherry salmon, carotenoid pigment is administered by incorporating carotenoid or a carotenoid-containing naturally occurring material (shrimp, crab, seaweed, spirulina, marigold, alfalfa, yeast, and so forth) into the feed (<u>Carotenoids in Marine Animals</u>, Koseisha Koseikaku Corporation, 1988; JP B 63-061907). These methods, however, are not used for the purpose of improving the meat quality of the above-cited farm-raised fish, and the resulting improvement still cannot be said to be satisfactory.

[0005]

Problems to Be Solved by the Invention

The present invention seeks to provide an additive for farm-raised fish feed that can solve the heretofore seen problems of a meat quality for farm-raised fish that is inferior to that of the meat of wild-caught fish, and that can therefore substantially improve the meat quality and body color of farm-raised fish.

[0006]

Means Solving the Problems

As a result of intensive and extensive investigations, the present inventors [sic] discovered that the aforementioned problems with farm-raised fish are substantially ameliorated by the administration to the fish of a feed that incorporates an additive comprising carotenoid mixed into phospholipid. The present invention was achieved based on this discovery. Thus, the present invention provides an additive for farm-raised fish feed, that improves the meat quality of farm-raised fish and that comprises 0.1 g to 10 g carotenoid incorporated in 100 g phospholipid; the present invention additionally provides a farm-raised fish feed that contains at least 2 g

phospholipid and at least 3 mg carotenoid in 100 g farm-raised fish feed.

[0007] Phospholipids are a biological structural component present in the cells and seeds of animals and plants and are constituted of, for example, phosphatidylcholine and/or phosphatidylethanolamine, phosphatidylserine, and so forth. The phospholipid used in the present invention can be exemplified by the lecithin produced from the process of expressing oil from soybean or rapeseed, the lecithin obtained from chicken egg yolk, and lecithin of fish egg origin. In general, mainly soy lecithin is used. The lecithin obtained by oil expression is ordinarily obtained as a viscous liquid containing about 60% lecithin and about 40% soy oil; the high-purity lecithin obtained by purification by removing the oil with organic solvent is a cream-colored powder.

[0008] The present invention can employ the particulate form as such, but can also use a dilution obtained using an oil or fat of animal or plant origin. Examples of plant oils and fats that can be used for dilution are soybean oil, corn oil, rapeseed oil, olive oil, benihana oil, and cottonseed oil, while the animal oils and fats can be exemplified by lard, tallow, and fish oil. Given the objective of the addition to feed, the proportion of

dilution with oil or fat is generally no greater than 10-fold.

[0009] Carotenoids are a constituent component of organisms in the form of the carotenoid pigments that express the meat color in fish or as provitamins. The carotenoids used in the present invention can be exemplified by astaxanthin, canthaxanthin, zeaxanthin, tunaxanthin, lutein, and β-carotene. These carotenoids may be obtained by chemical synthesis or by extraction from natural materials, and either of these may be used. Usable commercially available products include astaxanthin formulations, β-carotene crystals, and carotenoid blends containing 80% astaxanthin as natural krill oil.

[0010] In addition, natural substances that have been minced, finely diced, or ground can also be used; these natural substances can be exemplified by shrimp (*Neomysis intermedia*, krill) that contain approximately several mg% carotenoid (astaxanthin, canthaxanthin, lutein, and so forth); crabs; seaweed that contains approximately several 10 mg% carotenoid; spirulina; marigold; alfalfa; and red yeast, which contains approximately 50 to 100 mg% carotenoids. With regard to the blending proportions between the phospholipid and carotenoid,

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their types and amounts are determined according to the particular type of farm-raised fish; however, the range of 0.1 g to 10 g carotenoid per 100 g phospholipid is generally used while the range of 0.1 g to 1.0 g carotenoid per 100 g phospholipid is preferred.

[0011] The inventive additive for farm-raised fish feed is used incorporated in the feed that is given to the farm-raised fish. Available sources of minced fish meat (e.g., sardine, mackerel, horse mackerel, pike, Japanese sand lance, and so forth) are mainly used as the feed given to the farm-raised fish. These are minced, either directly or after freezing, and incorporation may then be carried out with the additional use of a binder such as CMC or guar gum, or administration may be carried out by incorporation into the minced fish meat that has been processed into fish powder.

[0012] The quantity of addition to the feed is 0.1 g/100 g feed to 10 g/100 feed and is preferably an addition that provides 2 g to 10 g phospholipid/100 g feed and 3 mg to 100 mg carotenoid/100 g feed. The interval of administration added to the feed will vary as a function of the concentration and fish species, but at least two weeks are required in order to manifest the effects associated with an increase in muscle.

[0013]

Function

The use of carotenoid by itself provides an accumulated color due to the migration of this pigment; however, its co-use with phospholipid was found to not only enhance this effect, but also to promote a stabilization of the non-carotenoid myoglobin pigment in the dark muscle, resulting in the manifestation and sustained appearance of a bright color. In addition, improvements are seen from the standpoint of the flavor and aroma, and melanin pigment deposition in the capillary vessels is also prevented.

[0014]

Effects of the Invention

(1) Ability to maintain the bright red color of the dark muscle

Fish muscle includes white muscle and dark muscle. The pigmentation of this red dark muscle is a color due to myoglobin pigment and differs from the carotenoids, and the dark muscle of farm-raised fish undergoes a very rapid color change. Bright red dark muscle is produced for the muscle of farm-raised fish that have continuously received feed containing the additive of the present invention, and

there is little change over the course of several days in filets made therefrom.

(2) Improvements to the taste and aroma

For example, the sardine used as feed contains lipid that contains large amounts of highly unsaturated fatty acids and is therefore prone to oxidation; the oxidized lipids migrate into the muscle and cause a deterioration in the meat quality of the farm-raised fish. The result is the generation of off-flavors and off-aromas for the muscle and a loss of commercial value. The additive of the present invention has the effect of synergistically inhibiting fish oil oxidation and also has a strong ability to restrain the peroxide concentration in the lipids of farm-raised fish. The administration of the additive of the present invention yields an excellent meat quality substantially lacking off-flavor and off-aroma in comparison to the absence of addition.

(3) Ability to prevent melanin pigment deposition

Red seabream, Japanese flounder, blow fish, grouper, and so forth, which are known as white-meat fish, present a black filamentous pattern due to the deposition of melanin pigment in the walls of the blood vessels in their muscle;

this results in a loss of commercial value. The administration of the additive of the present invention stops the deposition of melanin pigment in the blood vessel walls, resulting in little manifestation of the black filamentous pattern.

[0015]

Examples

The present invention is described more specifically by the examples given below. In the examples, % denotes weight% unless specified otherwise.

Example 1

Growth tests with feed that incorporates a soy lecithin/carotenoid mixture

Procedure: Japanese amberjack (2 years old, average body weight = 1.7 kg ± 0.3 kg) grown at the experimental fish farming facility of Mitsubishi Petrochemical on Karatsu Bay were divided into 5 sections of 20 fish each and a growth test was run for two months (from 1 July 1991 to 1 September 1991) in 2.5 m × 2.5 m synthetic fiber net pens. A feed was prepared by mixing minced sardine meat and Japanese amberjack feed from Mitsubishi Petrochemical

(binder, vitamins, and minerals added to fish powder and a plant-based feed of soy waste) at a 1 : 1 ratio; the additive described below for the particular section was added (the weight of the above-described mixture was used as 100%); and pellets were molded to yield the feed.

[0016] Test sections:

(1) 3% soy lecithin

(2) 10 mg astaxanthin/100 g feed

(3) 3% soy lecithin + 10 mg astaxanthin/100 g feed

(4) 3% soy lecithin + 10 mg β-carotene/100 g feed

(5) control section (no addition)

(6) provision of cut-up frozen sardine

After completion of the test, all of the fish were recovered and were processed into filets and stored in a freezer at -1°C. After 3 days, a 10-member panel carried out a sensory evaluation on the color of the dark muscle and the flavor and aroma of the meat.

[0017] Procedure for sensory evaluation: the filets from each test section were cut to a size suitable for sashimi and the panel performed the evaluation without knowing the test section number. A good meat quality was assigned to samples having a high total score on the following scale: 1 point: poor, 2 points: somewhat poor, 3 points: normal, 4 points: fairly good, 5 points: excellent. In addition, the

peroxide concentration in the lipid in the muscle from each section was determined by a microquantitative HPLC procedure using triphenylphosphine as reagent.

[0018]

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Table 1.
Sensory evaluation of Japanese amberjack muscle meat and organoperoxide concentration in the muscle lipids

test section	brightness of the dark muscle	flavor	aroma	organoperoxide concentration nmol/mg lipid
1	41	42	40	0.31 (± 0.12)
2	35	36	40	0.66 (± 0.34)
3	48	48	47	0.18 (± 0.10)
4	47	46	48	0.21 (± 0.13)
5	31	35	33	1.10 (± 0.75)
6	12	22	11	1.82 (± 0.51)

[0019]

Example 2

Antioxidation activity in sardine oil oxidation

Procedure: 4 g sardine oil (POV value = 5 meq/kg) containing a test reagent as described below was spread on circular filter paper (No. 2 from Toyo Roshi, diameter = 24 cm); the sardine oil was spread over the entire filter paper. This was then suspended in a dark room at an air temperature of 20 to 24°C and the change in the POV value

over 4 days was determined. The POV value was determined by extracting the sardine oil by processing in a mixer with 200 mL chloroform and then titrating the filtered extract with a sodium thiosulfate solution to obtained the POV value in meq/kg.

[0020] Test reagents:

(1) soy lecithin 3, 10 (%)

(2) astaxanthin 3, 10 (mg/100 g lipid)

(3) β-carotene 3, 10 (mg/100 g lipid)

(4) 3% soy lecithin + 3 mg astaxanthin/100 g lipid

(5) 3% soy lecithin + 3 mg β-carotene/100 g lipid

(6) 3% rapeseed lecithin

(7) 3% chicken egg lecithin

(8) control (no addition)

The results are given in Table 2.

[0021]

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Table 2.
Antioxidation activity in sardine oil oxidation (POV value in meq/kg)

test reagent	after 1 day	after 2 days	after 3 days	after 4 days
1: 3% soy lecithin 10% soy lecithin	11 5	20 12	43 16	52 28
2: 3 mg astaxanthin 10 mg astaxanthin	10 7	23 10	38 16	52 24
3: 3 mg β-carotene 10 mg beta-carotene	13 6	33 11	58 23	85 50
4: 3% soy lecithin + 3 mg astaxanthin	5	5	6	6
5: 3% soy lecithin + 3 mg β-carotene	5	10	12	16
6: 3% rapeseed lecithin	10	24	41	55
7: 3% chicken egg lecithin	8	12	35	40
8: control (no addition)	61	150	673	1325

[0022]

Example 3.

Test of the administration to the red seabream of a feed that incorporates a mixture of soy lecithin and astaxanthin

Procedure: Red seabream (average body weight = 760 g ± 38 kg) were held in 2.5 m × 2.5 m synthetic fiber net pens (4 sections, 20 per section) at the experimental fish farming facility of Mitsubishi Petrochemical on Karatsu Bay from 5 June 1991 to 20 September 1991.

Test feed: The test feed was a moist pellet containing the following in a 1 : 1 ratio: blended feed for red seabream (pre-soy lecithin addition) from Mitsubishi Petrochemical (binder, vitamins, and minerals added to fish powder and a plant-based feed of soy waste) and minced sardine. For the section in which *Neomysis intermedia* was added, moist pellets were prepared of 30% minced sardine, 20% *Neomysis intermedia*, and 50% of the aforementioned blended feed (pre-soy lecithin addition).

[0023] Test sections:

(1) 3% soy lecithin

(2) 3% soy lecithin + 10 mg astaxanthin/100 g feed

(3) 3% soy lecithin + 20% *Neomysis intermedia*

(4) control section (no addition)

Evaluation procedure (presence/absence of melanin pigment deposition): After the completion of the test, the muscle at the base of the dorsal fin of the red seabream was sampled (1 cm × 1 cm) at three locations (S-1, S-2, S-3) at approximately equal intervals moving toward the spine and the total length of the blackened capillary vessels in each 1 cm square was measured with a stereoscopic microscope. The total number for the three locations was

designated as the value for the single fish; the total value for each twenty fishes was determined to perform the evaluation. The results are reported in Table 3.

[0024]

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Table 3.
Presence/absence (cm) of melanin pigment deposition in capillary vessels of red seabream muscle

test section	sample location			
	S-1	S-2	S-3	total
(1) 3% soy lecithin	12	10	16	38
(2) 3% soy lecithin + 10 mg astaxanthin	3	6	0	9
(3) 3% soy lecithin + 20% *Neomysis intermedia*	8	5	5	18
(4) control section (no addition)	78	64	54	196

[0025] In addition, a sensory evaluation of the bright red color of the dark muscle was carried out among the test sections, and the results again showed that the addition of the mixture of soy lecithin and astaxanthin was effective.